Microbial Biological Control of Arthropods, Weeds, and Plant Pathogens: Risks, Benefits and Challenges

Pre-release Evaluation of Candidate Microbials

Physiological vs. Ecological Host Range

William L. Bruckart, III
USDA, ARS, FDWSRU
Ft. Detrick, MD

Why me?

- Personal experience
- Personal interest
- Importance in own program
- Some modicum of success

Why me?

- Common theme w/friends, incl.
  - "The Regulators"
  - Entomologists, and
  - Wife at dinner time
- Lead into the next talk

Why this meeting?

- Fundamental part of agent development
  - Basic info in decisions about release,
  - Consumes most resources and time
- Occurs regularly.
- Major grappling point for
  - Scientists, and
  - Regulators
- Not a new issue, but it persists …

Where is it important in BC by microbes?

- Exotic agents
  (classical control)
- Domestic agents
  (biopesticide application)
- BC diseases?
  (ecologically based)

What are we talking about?

Effect of artificial tests to determine which species may serve as host of a candidate biological control agent.

The Microbial Containment Greenhouse USDA-ARS-FDWSRU

1. 10,000 sq ft
   (7,500 under glass)
2. Entirely microbial
3. Two research missions

What are we talking about?

Ecological host range: that complement of species able to support development of a parasite or pathogen in nature.

What are we talking about?

Physiological host range: that complement of species able to support development of a parasite or pathogen under artificial (optimal or unnatural) test conditions.

Ecological vs. Physiological: What's the difference?

Removal of naturally-occurring constraints to encounter, attack, and development by parasites or pathogens.

Ecological vs. Physiological: What's the difference?

Addition of unnatural conditions

- Susceptible stage of test species
- High conc. of candidate agent
- Optimal placement of candidate
- Unnatural "opportunities" in tests

Ecological vs. Physiological: What's the difference?

Changes in tests from natural conditions often result in a larger list of species identified as capable of supporting a parasite or pathogen

What are we talking about?

- Interpretation of data
- Facilitating decision process by regulators.
- Determining true host range.
- Safety

  = Host specificity

Controlling Risk …

- Considering R = H x E, and
- Exposure (E) is assumed with foreign candidate organisms,
- Hazard (H) needs to be zero, or nearly so.

- Host specificity in a BC candidate eliminates Hazard.

Framework and Perspectives

- Not a new issue
- Many excellent papers by*:
  - Harris, Zwolfer (1968, 1971)
  - Wapshere (1974, 1989)
  - Watson (1984)
  - Evans (2000)
  - Briese (2005)
  - Berner et al. (2009)

*Among Others
Name = Microbiologist


"I THINK WE'VE GOT IT!"
"IS IT SAFE?"

Solutions(?)

- Field tests:
  - More practical for evaluating domestic biopesticide agents.
  - May be an issue overseas, if native N. Am species are tested.
- Physiol. study of susceptible rxn.
- Comparisons with species related to the candidate agent.
- Improved methods of analysis and prediction.

Examples

- *Puccinia carduorum* vs. musk thistle
- *P. jaceae* vs. yellow starthistle (YST)
- *Synchytrium solstitiale* vs. YST
- *Uromyces salsolae* vs. Russian thistle

Puccinia jaceae
and
Yellow starthistle

Puccinia jaceae for Biological Control of Yellow Starthistle

"Non-Target Effects"

Resistant reaction on a related species, diffuse knapweed (DK)

P. jaceae Versus *P. carthami* On Safflower

Safflower Grower's Question: Can *Puccinia jaceae* infect safflower seedlings?

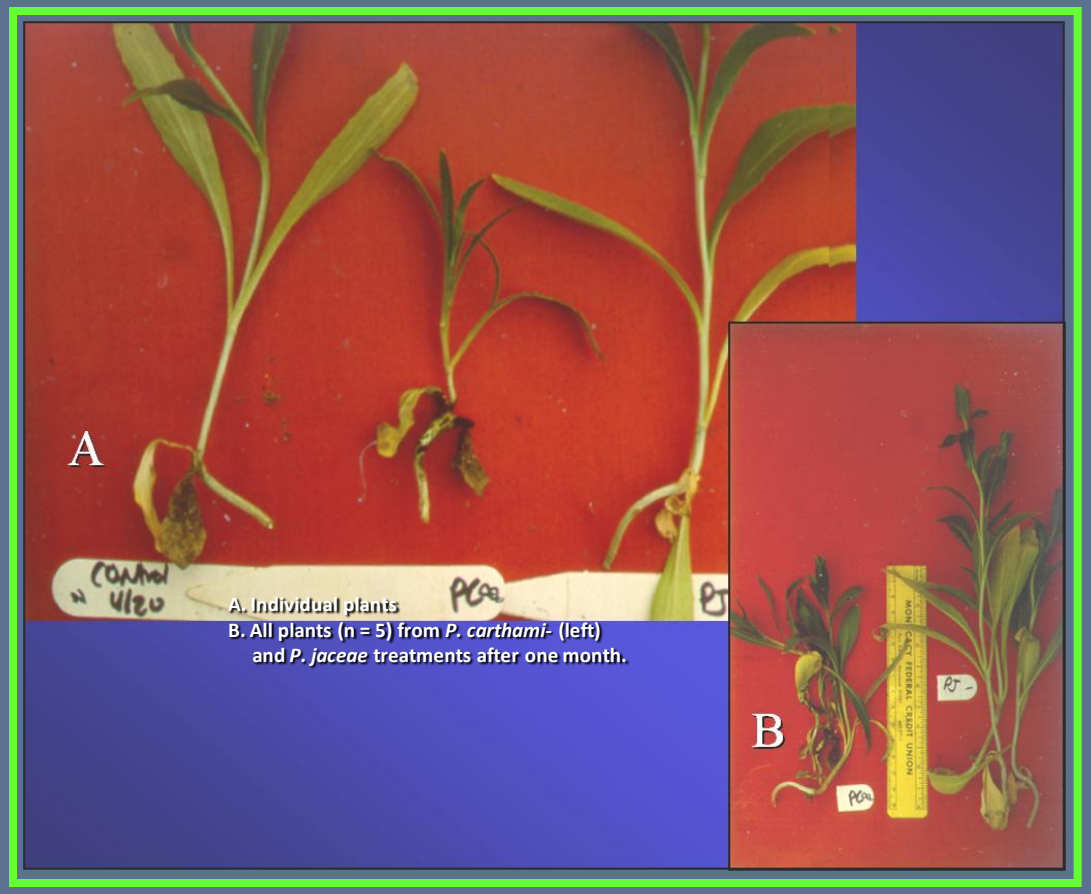
P. jaceae teliospore (t), basidium (b) and germinating basidiospores (bsp).

?

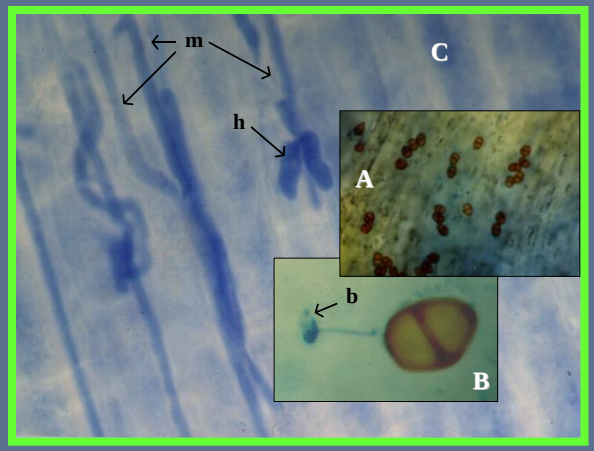
Canker on safflower hypocotyl after *P. carthami* teliospore infestion.

The Answer …

"NO"



Safflower plants inoculated
by *Puccinia carthami* or *P. jaceae*



Puccinia carthami in a
safflower hypocotyl

Synchytrium solstitiale

False Rust on Yellow Starthistle

Synchytrium solstitiale

Inoculation of Yellow Starthistle

Synchytrium solstitiale

Safflower, ‘CW 99-OL’

Yellow Starthistle

Controls Inoc.

Ecological vs. Physiological:

Potential New Association?

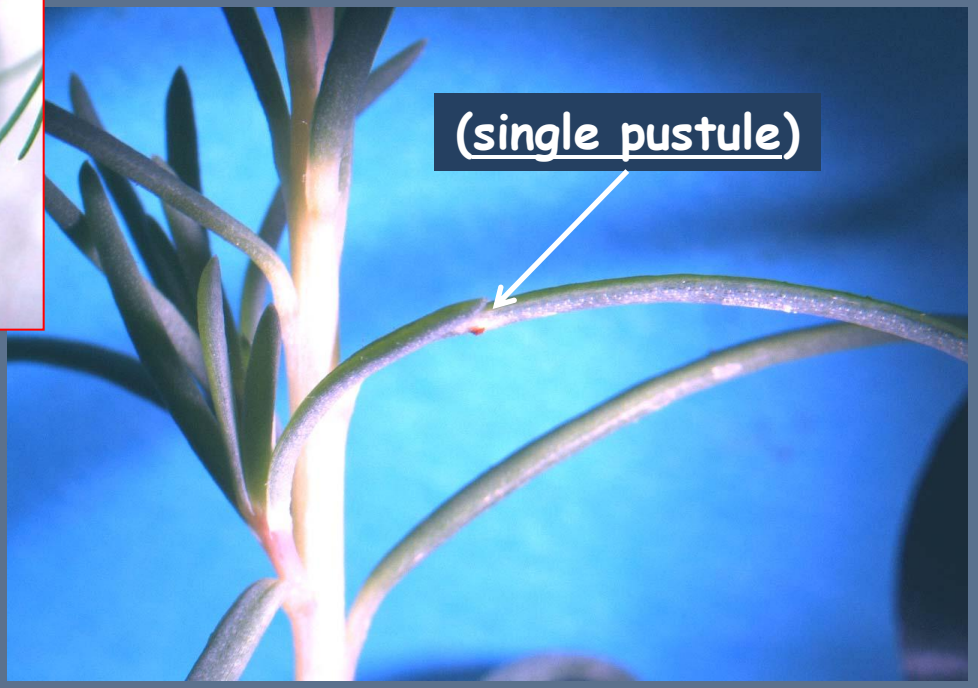
Ecological hosts?

Or

Physiological hosts?

Uromyces salsolae

Salisola tragus



Suaeda californica

Salicornia virginica (= *S. depressa*)

Ecological vs. Physiological:

Potential New Association?

Ecological hosts?

Or

Physiological hosts?

Ecological vs. Physiological?

Uromyces giganteus on *Suaeda californica*

U. peckianus on *Salicornica virginica*

Conclusions

- Much time and effort go into HRD.
- Challenges include:
  - Getting material to test.
  - Getting test material to grow.
  - Realistic tests.

Conclusions

- Scientists make judgment about safety before making proposals.
- HRD is made under a microscope; i.e., often looking at fine detail.

Conclusions

- Some response data from artificial tests difficult to interpret for field scenarios.
- No matter how much information is developed, there will be risk associated with every decision.

Questions?